

WHAT IS CLAIMED IS:

1. A method of forming and dispensing minute volume segments of a material in a microfluidic device, said method comprising the steps of:

providing a microfluidic device that includes a body having first, second, third, and fourth microchannels formed therein, said first, second, third, and fourth microchannels communicating at a first intersection and said first microchannel being connected to a source of a first material;

providing a first focusing channel in said body having one end in fluid communication with a source of a focusing material and a second end in fluid communication with said first channel between said source of the first material and the first intersection;

transporting a stream of the first material through said first channel toward the first intersection, said stream of first material having a width;

transporting a stream of the focusing material from the first focusing channel into said first channel, such that the width of the stream of first material in said first channel is narrowed; and

dispensing a volume segment of the narrowed first material stream into the fourth channel.

2. A method as set forth in Claim 1 comprising the step of transporting a buffer material in said third and fourth channels such that said buffer material acts on said narrowed stream of the first material.

3. A method as set forth in Claim 1 wherein the step of dispensing the volume segment of the narrowed first material stream into the fourth channel comprises the steps of:

transporting a first buffer material through said third channel toward the first intersection; and

transporting the volume segment of the narrowed first material stream

through the fourth channel.

4. A method as set forth in Claim 1 or 2 further comprising the steps of:
providing a second focusing channel in said body having one end in fluid communication with a source of focusing material and a second end in fluid communication with said first channel between the source of the first material and the first intersection; and

transporting a second stream of the focusing material from the second focusing channel into said first channel such that the width of the stream of the first material in said first channel is narrowed.

5. A method as set forth in Claim 4 wherein the step of dispensing the volume segment of the narrowed first material stream into the fourth channel comprises the steps of:

transporting buffer material through said third channel toward the first intersection; and

transporting the volume segment of the narrowed first material stream through the fourth channel.

6. An apparatus for forming and dispensing minute volume segments of a material in a microfluidic device, the apparatus comprising:

a substrate having first, second, third, and fourth microchannels formed therein, said microchannels communicating at a first intersection and said first microchannel being connected to a source of a first material;

a focusing channel formed in said substrate and having one end in fluid communication with a source of a focusing material and a second end in fluid communication with said first channel between said source of the first material and the first intersection;

means for transporting a stream of the first material through said first channel toward said first intersection, said stream of first material having a width;

means for transporting a stream of the focusing material into said first channel, whereby the width of the stream of first material in said first channel is narrowed; and

means for dispensing a volume segment of the narrowed first material stream into the fourth channel.

7. An apparatus as set forth in Claim 6 further comprising means for transporting a buffer material in said third and fourth channels such that said buffer material acts on said narrowed stream of the first material.

8. An apparatus as set forth in Claim 6 wherein the means for dispensing the volume segment of the narrowed first material stream into the fourth channel comprises:

means for transporting a buffer material through said third channel toward the first intersection; and

means for transporting the volume segment of the narrowed first material stream through the fourth channel.

9. An apparatus as set forth in Claim 6 or 7 further comprising:
a second focusing channel in said body having one end in fluid communication with a source of focusing material and a second end in fluid communication with said first channel between the source of the first material and the first intersection; and

means for transporting a second stream of the focusing material from the second focusing channel into said first channel such that the width of the stream of the first material in said first channel is narrowed.

10. An apparatus as set forth in Claim 6 wherein the means for transporting the stream of the first material and the means for transporting the stream of the focusing material comprise a means selected from the group consisting of

electrokinetic means for effecting the transporting of the respective materials, pressure-driven means for effecting the transporting of the respective materials, and a combination thereof.

11. An apparatus as set forth in Claim 7 wherein the means for transporting the stream of the first material, the means for transporting the stream of the focusing material, and the means for transporting the buffer material comprise a means selected from the group consisting of electrokinetic means for effecting the transporting of the respective materials, pressure-driven means for effecting the transporting of the respective materials, and a combination thereof.

12. An apparatus as set forth in Claim 8 wherein the means for transporting the stream of the first material, the means for transporting the stream of focusing material, the means for transporting the buffer material, the means for transporting the buffer material, and the means for transporting the volume segment of the narrowed first material comprise a means selected from the group consisting of electrokinetic means for effecting the transporting of the respective materials, pressure driven means for effecting the transporting of the respective materials, and a combination thereof.

13. An apparatus as set forth in Claim 9 wherein the means for transporting the stream of the first material, the means for transporting the stream of focusing material, the means for transporting the buffer material, and the means for transporting the second stream of focusing material comprise a means selected from the group consisting of electrokinetic means for effecting the transporting of the respective materials, pressure driven means for effecting the transporting of the respective materials, and a combination thereof.

14. A method as set forth in Claim 3 which further comprises the step of reversing the direction of the transporting of the stream of the first material in the

first channel.

15. A method as set forth in Claim 5 which further comprises the step of reversing the direction of the transporting of the stream of the first material in the first channel.

16. An apparatus as set forth in Claim 8 which further comprises means for reversing the direction of the transporting of the stream of the first material in the first channel.

17. A method as set forth in Claim 4 wherein the step of transporting the second stream of the focusing material comprises transporting the second stream of the focusing material from the focusing channel into the first channel such that the width of the stream of the first material in the first channel is narrowed substantially along the center axis of the first channel.

18. An apparatus as set forth in Claim 9 wherein the means for transporting the second stream of the focusing material comprises means for transporting the second stream of the focusing material from the focusing channel into the first channel such that the width of the stream of the first material in the first channel is narrowed substantially along the center axis of the first channel.

19. A method as set forth in Claim 2 wherein the step of transporting the buffer material in the third and fourth channels comprises the step of controlling the flow of the buffer material in the third and fourth channels such that the buffer material expands, maintains, or further confines the stream of first material.